

Galactic Cannibalism: The Origin of the Magellanic Stream *

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1. Background

The aim of this work is to model the formation of the Magellanic Stream via the resulting tidal gravitational field from the merger of the Milky Way with the Large and Small Magellanic Clouds (LMC and SMC, respectively). Two popular, yet competing, scenarios for the Stream's formation are based upon tidal disruption (Lin & Lynden-Bell 1977; Gardiner & Noguchi, 1996) or ram-pressure stripping (Moore & Davis 1994). The recent discovery of the Leading Arm Feature (Putman et al. 1998) has strengthened the case for tidal disruption, in which both trailing and leading gas streams are a natural outcome.

2. Preliminary Simulations

To simulate the merger of the Milky Way–LMC–SMC system, we used the `TreeSPH` code of Kawata (2001) which includes a self-consistent treatment of self-gravity, gas dynamics, radiative cooling, star formation, supernova feedback, and metal enrichment. The initial conditions for each galaxy was constructed using `GalactICS` (Kuijken & Dubinski 1995). Starting with the current positions of the Clouds, orbits were integrated backwards in time (similar to Murai & Fujimoto 1980), resulting in appropriate initial conditions. We then traced the system's evolution from time $T=-2$ Gyr to the present.

We next compared the results of our pure N-body mergers with those of our full hydrodynamics simulations (including star formation, cooling and supernova feedback). In the N-body only case, we found that material from the SMC was tidally stripped, resulting in the formation of the Magellanic Stream and an associated Leading Arm (see left two panels of Figure 1).

However, observations show that the Stream is apparently devoid of stars, comprised primarily of gas (e.g. Brück & Hawkins 1983; Osthheimer et al. 1997). In our full hydrodynamics simulations (with star formation), the SMC was again severely disrupted. In this case though

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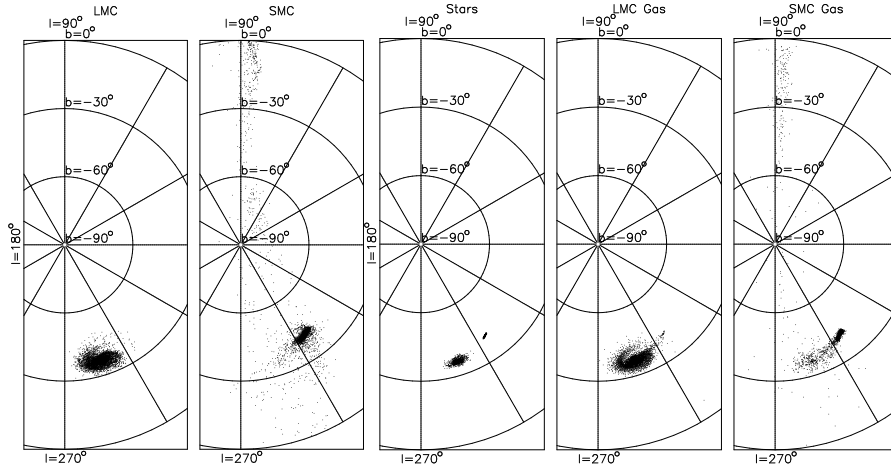


Figure 1. The left two panels show the present-day N-body only results for our 3-galaxy merger; the LMC and SMC particles are shown. The three right panels show the results of the full hydrodynamics 3-galaxy merger model with (from left to right) the present-day positions of the stars, the LMC gas, and the SMC gas.

we found that the Stream contained only gas stripped from the SMC, with no accompanying stars (see right three panels of Figure 1). The outer tenuous material of the SMC – gas – was stripped to produce the Stream in both cases.

3. Discussion

Preliminary hydrodynamical and N-body simulations were undertaken with self-consistent star formation and gas heating/cooling. Our models successfully recover a pure gas Magellanic Stream, similar to that observed. Self-consistent treatments of star formation histories of the LMC and SMC are now underway. This will rectify one of the remaining short comings of the models – the near order-of-magnitude discrepancy between the mass of the simulated and observed Stream. These results represent the first self-consistent gas + N-body + star formation simulations of the Magellanic System.

References

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